ARI Research Note 2001-09

Digital Skill Training Research: Preliminary Guidelines for Distributed Learning

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June 2001

U.S. Army Research Institute
for the Behavioral and Social Sciences

U.S. Army Research Institute
for the Behavioral and Social Sciences

A Directorate of the U.S. Total Army Personnel Command

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Director

Research accomplished under contract
for the Department of the Army

TRW Systems

Technical review by

Robert A. Wisher

NOTICES

REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
June 2001	Final	February, 2000 – April, 2001

4. TITLE AND SUBTITLE
Digital Skill Training Research:
Preliminary Guidelines for Distributed Learning

5a. CONTRACT OR GRANT NUMBER
DASW01-99-D-0013
Delivery Order No. 5

5b. PROGRAM ELEMENT NUMBER
2O262785

6. AUTHOR(S)
Jerry M. Childs (TRW Systems)

5c. PROJECT NUMBER
A790

5d. TASK NUMBER

5e. WORK UNIT NUMBER
620

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

10. MONITOR ACRONYM
ARI

11. MONITOR REPORT NUMBER RN2001-09

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 words)*:

This task was aimed at the development of guidelines for distributed learning (DL). A matrix was generated to evaluate the effectiveness of various DL media for training representative knowledge/skill types. Of the approximately 200 DL studies initially reviewed, only 15 met predetermined selection criteria (empirical, learning outcome focus, conducted since 1996, applied training environments). Using a 3-point Likert scale, each study was rated according to degree and direction of statistical difference reported between treatment (DL) and control group learning outcomes. Effect sizes were computed for those studies reporting standard deviations in learning outcomes. The majority of studies rated (77%) showed no significant difference in learning outcomes between DL-trained groups and their controls. Where differences were found, they favored DL-trained groups. Twelve factors are recommended as guidelines for designing, conducting, and evaluating effective DL.

15. SUBJECT TERMS Distributed Learning, Learning Evaluation, Training Evaluation, Learning Media/Methods, Knowledge/Skills

SECURITY CLASSIFICATION OF					
16. REPORT	17. ABSTRACT	18. THIS PAGE	19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
Unclassified	Unclassified	Unclassified	Unlimited	63	Dr. Robert A. Wisher 703-617-5540

ACKNOWLEDGEMENT

Research to support the development of Distributed Learning Guidelines outlined in this report was conducted by Ms. Carol Sullivan of TRW Systems. She assisted in identifying, reviewing, and classifying studies as well as developing appendix materials.

DIGITAL SKILL TRAINING RESEARCH:
PRELIMINARY GUIDELINES FOR DISTRIBUTED LEARNING

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INTRODUCTION

Delivery Order (DO) 5 of the Digital Skills Training Research (DSTR) project is aimed at the identification of digital skill acquisition and retention factors. Its overall purpose is to document patterns of knowledge/skill loss for Military Intelligence (MI) and Field Artillery (FA) and to introduce prototype training interventions to improve skill retention. These interventions are based on constructivist learning approaches that require the learner to relate current content to previously learned material and to actively build on prior knowledge/skills.

An additional task under DO 5 concerns the development of guidelines for distributed learning (DL), an increasingly viable means for delivering instruction in the Army. Distributed learning, alternatively termed distance learning, has been defined by the Los Alamos National Laboratory as "structured learning that takes place without the physical presence of the instructor." The Air Education and Training Command defines DL as "any method of presenting training that is interactive and in which students are physically separate from the instructor." Hedberg, Brown, and Arrighi (1997) define DL by the two dimensions that comprise its delivery—space and time. The following DL combinations are possible:

1. *Same-place and same-time: synchronous delivery with instructor and learner collocated.*
2. *Different-place and same-time: synchronous delivery with instructor and learner remotely located.*
3. *Same-place and different-time: asynchronous delivery with instructor and learner collocated.*
4. *Different-place and different-time: asynchronous delivery with instructor and learner remotely located.*

DL enables the instructor to be virtual when learning is facilitated via technology (computers, networks, databases). Instructional content must be designed to enhance learning with or without the physical presence of an instructor. It is this instructional design issue that is at the heart of the controversy regarding DL. The following questions should be addressed regardless of whether the content is delivered at a distance, or more conventionally in a classroom setting.

- What are we trying to teach (skills, knowledge; facts, rules, principles, abstract concepts)?
- What is the level of preparedness of learners?
- What is their learning background relative to the content?
- How will we know when learning has occurred? How can we document learning?
- How much learning must occur to achieve mastery of the material?
- What are consequences of not learning the content?
- How do we measure transfer from the learning environment to the applied setting?
- How frequently must learners practice or be retrained to sustain proficiency?

While DL is not new—correspondence courses are almost as old as the postal system—there has been a dramatic increase in its use as computer and Internet technology has evolved. Initially, DL growth was associated with satellite-based learning systems (one-way and two-way audio and video). For the past decade, DL also has been delivered via the Web and on organizational intranets. The International Data Corporation estimates that IT-related Web-based training will surge to more than $6 billion by 2002—a compounded annual growth rate of nearly 95 percent over 1999 expenditures. Ragan's Strategic Training Report (1999) predicts even more aggressive growth rates, estimating that corporate Web-based training expenditures by American corporations will be in the $10 billion range by 2002. Spurred by DL initiatives among all military services, and especially the Army, Department of Defense (DoD) DL budgets are increasing exponentially. Currently, the FY 2001 DoD budget has approximately $7 billion earmarked for training and recruiting (DoD, 2000).

Numerous factors are affecting DL's projected growth rates. Distance learning is accessible, increasingly interactive and engaging, allows for remote collaboration among students and instructors, and significantly reduces travel costs. For these and other reasons, military DL has been reported to have a very encouraging future (Barry and Runyan, 1995; Chute, Thompson, and Hancock, 1999).

But DL is not a panacea. Indiscriminate use of the technology for its own sake has little or no learning benefits. Like conventional training and education, poorly designed on-line content is almost certain to alienate learners. Clark (1983) has asserted that media do not influence learning under any conditions. Instead, evidence suggests that "media are mere

vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition."

In a benchmark report, Russell (1999) cited some 350 studies reporting "no significant difference" between technology-delivered DL and conventional classroom instruction. Phipps and Merisotis (1999), Machtmes and Asher (2000), Champagne and Wisher (2000), Wisher, Champagne, Pawluk, Eaton, and Curnow (1999), and others have asserted that Russell's findings are grounded on ill-conceived and poorly designed studies that are characterized by numerous shortfalls including:

- Lack of controls
- No/ineffective experimental design
- Confounding of student experience with learning
- Non-random assignment of participants
- Subjective assessments of effectiveness
- Lack of explicitly defined mastery criteria
- Absence of pre-tests and in many cases, post-tests
- No longitudinal follow-ups

Wisher (2000) recently described four principal threats (Table 1) to the internal validity of DL research. These threats confound the interpretation of DL effects on learning outcomes.

Table 1.
Threats to Internal Validity of DL Findings

Threat	Description
History	Skill/knowledge differences may be due to learning or experience not attributable to DL.
Maturation	Skill/knowledge differences may be due to learners becoming more fatigued or less interested in the program over time.
Mortality	Learners may become discouraged and drop out of DL program so that average post-test scores exceed average pre-test scores.
Test Sensitization	Learners may be cued by pre-test measures to focus on those knowledge-based items that enhance their post-test scores regardless of program content.

Jones and Paolucci (1996) have estimated that less than 5 percent of published DL research is sufficiently empirical, quantitative, and valid to support conclusions about DL learning outcomes. Research that can be meaningfully used to predict DL success is woefully inadequate (Navarro and Shoemaker, 2000). The levels of technology effectiveness on enhancing the learning process remain to be seen (Recker, 1997). Bonk and Wisher (2000) have outlined the requirements for collaborative learning environments that are learner-centered and can be applied within networked simulations. They further describe differences between education and training that must be considered in formulating our instructional design and delivery strategies.

Guidelines are needed for selection and application of DL methods and media for applied researchers, developers, and practitioners. These guidelines should be incorporated with instructional design and content issues, experimental design, and measurement and evaluation factors. DL guidelines should stem from assessments of media and methods relative to types of knowledge and skills to be imparted. Rapid developments in training delivery systems demand that research continuously re-examine which technology is best suited for particular skill and knowledge types (Machtmes and Asher, 2000).

The majority of studies aimed at DL effectiveness are based on educational (vs. training) settings and on the collection of observational data (Champagne, Wisher, Pawluk, and Curnow, 1999). Very little research has been conducted to determine the interrelationships among individual learning styles and DL content (Liu and Ginther, 1999). The present research was aimed at developing DL guidelines stemming from empirical studies that contain measurable and controllable training applications.

PURPOSE AND SCOPE

This task was designed to provide a framework for interpreting the effectiveness of DL methods/media for facilitating various types of learning. One of the most influential models of training evaluation over the past 30 years is Kirkpatrick's four-level model (Kirkpatrick, 1998). He suggests that training evaluations should address four general areas: reaction, learning, behavior, and results. The model is presented in Table 2 (adapted from Childs, 1996). Kirkpatrick's model highlights the various levels that should be addressed as part of training system evaluations.

Table 2.
Kirkpatrick's Four Levels of Evaluation

Level and Type	What is Measured and Evaluated	Measurement Method
1: Learner Reaction	• Satisfaction • (The "Smile Factor") • Course Materials Ratings • Content Delivery Effectiveness	• End of Training Evaluation or Critique
2: Learning	• New Knowledge, Skills, and Attitudes (KSA) Attainment • Objectives Mastery	• Final Examination • Performance Exercise • Pre-/Post-Tests
3: Application	• Use of KSA on Job • Training Transfer • Individual or Team Improvement	• Job Performance Outcomes
4: Results	• Return on Training Investment • Organizational or Corporate Benefits	• Cost Benefits Analysis • Business Outcomes

The focus of the present research was on learning outcomes (Level 2 evaluations) generated from empirical studies of training effectiveness (use of treatment and control groups with at least ordinal-level measures and inferential statistics). Generally, research has shown that learner attitudes are not effective predictors of learning outcomes (Moore and Kearsley, 1996). Yet as Figure 1 shows, the American Society of Training and Development (ASTD) indicates that the vast majority of corporate training assessments focus on how learners perceive their learning experience (Kirkpatrick Level 1) rather than on how or what they learn (ASTD, 1997). Fewer than one-half of the 100 large companies surveyed in 1997 indicated that they assess learning outcomes (Level 2) and only about 10% reported training transfer evaluations (Level 3). We are not aware of counterpart data gathered on the DoD, but would expect the incidence of Level 2 and 3 evaluations to be higher for military settings. Based on trends across the three years reported by ASTD, there is little reason to expect significant changes in the Figure 1 rates since 1997. Although corporations are increasingly adopting technology-based training, there is little emphasis on evaluating training effectiveness via learning outcomes.

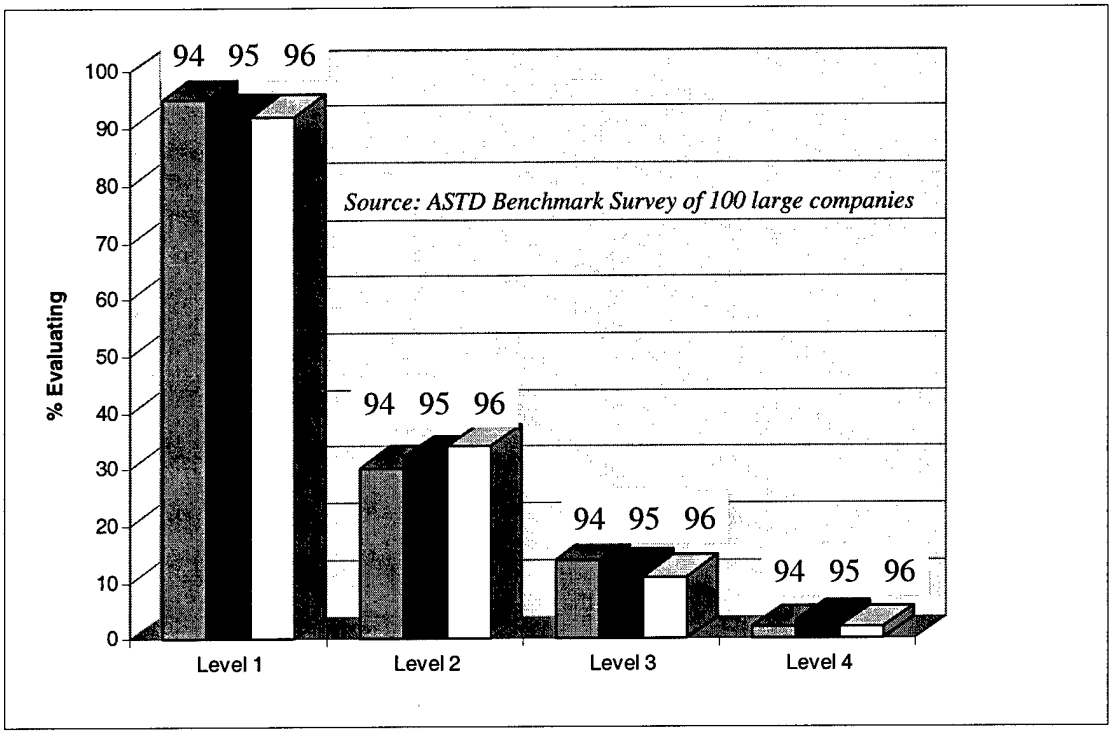

Figure 1. Levels of Training Assessments as Reported by American Business

DL data not based on empirical studies were considered out of scope for this effort. Non-empirical DL studies and references are summarized in Appendix A.

Our research focused on studies of training effectiveness conducted since 1996. We also reviewed earlier studies provided by the Army Research Institute (ARI) for the purpose of potential inclusion in the evaluation. A matrix was generated to evaluate DL guidelines. Our goal was to include in the matrix knowledge/skill types addressed by empirical investigations and DL methods/media utilized to deliver the training. We were less concerned with educational applications (university studies) than with those aimed at performance-based training. Similarly, greater emphasis was placed on applied training (industrial and military applications) than on academic learning environments. Kindergarten-12 studies were excluded since the goal was to focus on adult learning. Priority was given to those studies that assessed the effectiveness of DL methods relative to traditional classroom-based instruction. Studies that assessed measurable learning outcomes to include statistical assessments of learning were considered higher priority than those that were descriptive in nature.

METHOD

To accomplish the objectives of the study, we followed the general approach described below.

1. Identification and review of approximately 200 DL studies and other data sources from ARI and from literature and Web site reviews.

TRW employed several sources to gather the study data. These included the professional DL literature, ARI DL-related documents, and DL Web sites. We collected some 200 DL references published in professional journals such as the *American Journal of Distance Education, Distance Education,* and the *Journal of Asynchronous Learning Networks.* We also reviewed DL conference proceedings such as those published by the University of Wisconsin as well as government and industry Web sites containing pertinent information. Research was reviewed from ARI and other DoD and non-military government organizations concerned with DL. We conducted DL literature reviews in the University of New Mexico library and purchased proceedings from DL industry conferences and professional meetings.

2. Discussions with ARI and other DL experts.

We conferred with ARI and DL experts from the University of New Mexico and Indiana University. We also attended professional conferences (e.g., the E-learning conference) that included DL-related presentations.

3. Selection and rating of DL studies.

From the initial study population, we applied selection criteria (post-1996 publication dates, empirical, training-oriented, focused on learning outcomes) to arrive at those DL studies to be rated within the evaluation matrix. We evaluated those studies against 12 evaluation factors gleaned from the literature. We constructed an evaluation matrix and rating tool, and assigned the studies to the matrix based on DL media (video, audio, CBT) and knowledge types (perceptual-motor, procedural, cognitive). We then rated the effectiveness of the DL media for training various skill/knowledge types and computed effect sizes where possible. Under Results, we provide a brief description of our interpretation of findings and discuss the relevance of matrix summary data.

RESULTS

Consistent with findings reported by Wisher et al. (1999), a significant majority of the 200 studies we reviewed contain anecdotal and/or opinion-based data. Most of the studies reviewed lack valid measurements of learning outcomes (Kirkpatrick Level 2 measures) and the majority include no (or flawed) experimental designs. While many of the studies contain useful information for designing, developing, delivering, and managing DL content, data were unusable as reported. Of the study population reviewed, only 15 DL studies met selection criteria described under Purpose and Scope. The studies are summarized in Table 3. The purpose of downselecting to these 15 studies was to rate DL method/media effectiveness for training various skill/knowledge types.

Table 3.
DL Studies Meeting Selection Criteria

Ref No.	Authors	Title	Description
1	Bramble & Martin (1995)	The Florida Teletraining Project: Military Training via Two-way Compressed Video	For five different content areas, students trained via the Army's TNET system performed significantly better ($p<0.001$) on post-tests than pre-tests. Repeated measures design with no control group.
2	Drenth, Kubisiak, & Borman (2000)	An Examination of the Effectiveness of Distance Learning for the Battle Staff NCO Course	VTT groups performed almost identically on Job Knowledge Tests ($p=0.57$) to groups trained in residence at Fts. Bliss and McCoy.
3	Howard, Henry, Kinney, & Dannhaus (1991)	Distributed Training Strategy Training Effectiveness Analysis: MOS 63W Desktop Video Pilot Study	Groups trained via desktop video performed significantly better ($p<0.01$) than controls on 4 of 6 lessons and equally as good on the other two.
4	Keene & Cary (1990)	Effectiveness of Distance Education Approach to U.S. Army Reserve Component Training	Students receiving VTT achieved significantly higher scores ($p<0.001$) than controls on 3 of 4 learning outcome measures.

Ref No.	Authors	Title	Description
5	Moshinskie, Jarvis, Hobbs, & Roden (1996)	The Effects of Using Distance Learning Technologies in Training Rural EMS Providers When Learner-Centered Designs are Used	EMS students trained on advanced life support courses via 2-way audio and 2-way audio/video (satellite-based) performed as well as those trained in classroom.
6	Phelps, Wells, Ashworth, & Hahn (1991)	Effectiveness and Costs of Distance Education Using Computer-Mediated Communication	CMC group performed significantly better ($p<0.001$) than controls on leadership test outcomes. For engineering course, no significant differences in test scores were found.
7	Simpson, Pugh, & Parchman (1991)	Empirical Comparison of Alternative Video Teletraining Technologies	Two-way video does not facilitate student learning relative to the use of one-way video during VTT to support Admin and Operations courses. No control group.
8	Simpson, Pugh, & Parchman (1992)	The Use of Videoteletraining to Deliver Hands-on Training: Concept Test and Evaluation	VTT groups trained remotely performed as well as those trained in local classrooms on three end-of-course hands-on skills tests ($p>0.05$).
9	Simpson, Wetzel, & Pugh (1995)	Delivery of Division Officer Navy Leadership Training by Videoteletraining: Initial Concept Test and Evaluation	Navy Leadership tests showed that groups trained via VTT local and VTT remote performed nearly identically to those trained in the classroom.
10	Wetzel (1996)	Distributed Training Technology Project: Final Report	Four courses delivered via VTT. Statistics are difficult to interpret. Remote VTT groups performed as well as local VTT groups on most measures.
11	Wetzel, Pugh, Van Matre, & Parchman (1996)	Videoteletraining Delivery of a Quality Assurance Course with a Computer Laboratory	Same as Wetzel (1996), with results reported only for one (QA) course. No significant difference between local and remote VTT groups on exam grades.

Ref No.	Authors	Title	Description
12	Wetzel, Radtke, Parchman, & Seymour (1996)	Delivery of a Fiber Optic Cable Repair Course by Videoteletraining	Procedural errors were no higher for VTT group than for controls. Learning outcomes were not statistically different among VTT local, VTT remote, and control groups.
13	Whetzel, Felker, & Williams (1996)	A Real World Comparison of the Effectiveness of Satellite Training and Classroom Training	U.S. Postal Service employees trained via satellite (VTT) performed significantly better than classroom-trained group
14	Wisher & Curnow (1999)	Perceptions and Effects of Image Transmissions during Internet-Based Training	Video capability for Internet-based audiographics course on information operations produced no better learning than without video.
15	Wisher, Priest, & Glover (1997)	Audio Teletraining for Unit Clerks: A Cost-Effectiveness Analysis	Audio teletrained group performed significantly better (higher Go rates; $p<0.001$) than control group.

Prior to rating the effectiveness of each DL method/medium for training various skill/knowledge types, we assessed the DL studies against 12 evaluation factors. This assessment is summarized in Figure 2. While these evaluation factors are not intended to be comprehensive, they represent desirable characteristics of DL studies as gleaned from our literature review and discussed with ARI. Figure 2 includes the studies identified for evaluating the effectiveness of methods/media for training the various DL skill and knowledge types. If studies contained sufficient information to verify that the evaluation factor was addressed, a check mark was assigned to the applicable cell. No attempt was made to rate the degree of a factor's effectiveness, only that it was, or was not, addressed by the study. Neither was an attempt made to differentially weight factors since any factor could be more or less critical depending on study context and objectives.

While the majority of the Figure 2 studies included sound experimental and instructional designs and various statistical analyses, only 37% of the cells include check marks.

With regard to study compliance with the individual evaluation factors in Figure 2:

- Three factors—instructional design, experimental design, and statistical analyses—were addressed by virtually all of the studies.

- No study addressed more than six evaluation factors.
- Only two studies are non-military in nature; these assessed Emergency Medical Service personnel (Study 5) and U.S. Postal Service workers (Study 13).
- No study reported randomly assigning students to treatment and control groups.
- Only three studies reported the attrition rates of DL students.
- Specific roles and responsibilities for students in the learning process were not covered (three studies reported preparation and planning efforts on the part of students).
- Over half of the reports alluded to instructor initiative in assisting/mentoring students.
- Only three studies included the use of multiple DL technologies.
- None of the studies reported the use of digital libraries.
- Only two studies incorporated training transfer evaluations (Kirkpatrick Level 3).
- Two studies included program/course effectiveness evaluations.

DL Studies \ *Evaluation Factors*	Instructional Design	Experimental Design	Learners randomly assigned [1]	Statistical Analysis	Program/Course Evaluation [2]	Training Transfer Evaluation	Individual Learning Styles [3]	Attrition Rates Reported [4]	Multiple DL Technologies	Digital Libraries Used	Student Accountability	Instructor Accountability
1. Bramble and Martin, 1995	✓	✓*		✓					✓			
2. Drenth, Kubisiak,& Borman, 2000	✓	✓		✓		✓						✓
3. Howard, Henry, Kinney, & Dannhaus, 1991	✓	✓		✓								
4. Keene and Cary, 1990	✓	✓		✓								
5. Moshinskie, Jarvis, Hobbs, and Roden, 1996	✓	✓		✓					✓			✓
6. Phelps, Wells, Ashworth, & Hahn, 1991	✓	✓		✓				✓			✓	✓
7. Simpson, Pugh, and Parchman, 1991	✓	✓*		✓					✓		✓	✓
8. Simpson, Pugh, and Parchman, 1992	✓	✓		✓		✓		✓				✓
9. Simpson, Wetzel, and Pugh, 1995	✓	✓		✓								✓
10. Wetzel (1996)	✓	✓		✓	✓						✓	
11. Wetzel, Pugh, Van Matre, & Parchman (1996)	✓	✓		✓								✓
12. Wetzel, Radtke, Parchman, & Seymour, 1996	✓	✓		✓								✓
13. Whetzel, Felker, and Williams (1996)	✓			✓								
14. Wisher and Curnow (1999)	✓	✓		✓	✓		✓					
15. Wisher, Priest, and Glover (1997)	✓	✓		✓				✓				

* No control group.

[1] Military training schedules often preclude random assignment of learners to experimental and control conditions.

[2] Kirkpatrick Level 1 measures were not included since they are not empirical.

[3] Due to standardization requirements, individual learning styles are seldom addressed in military studies.

[4] For military studies, learner attrition is generally low.

Figure 2. DL Evaluation Factors Applied to the Selected Studies

Figure 2 suggests that DL evaluations are truly multidimensional and that DL research conducted over the past five years is addressing only a few of those dimensions. Of the 200 studies initially reviewed, those represented in Figure 2 are the most empirically rigorous. Thus, the DL literature continues to be dominated by anecdotal or other qualitative information. Even data on the incidence, design, and cost of DL for educational and training purposes are suspect due to the absence of standards for defining their use. The Advanced Distributed Learning (ADL) initiative, discussed under Current Programs, promises to incorporate standards and guidelines for improving the validity and reliability training effectiveness data.

We used the taxonomy included in Appendix B to classify skill/knowledge types. This classification is largely derived from Bloom's (1956) Taxonomy (Table 4) for characterizing types of learning. The rating of the effectiveness of the method/medium for imparting that particular skill/knowledge type was then determined for that cell along with an effect size, if reported.

Table 4.
Bloom's Taxonomy—The Six Levels of Learning

Learning Style	Definition
Knowledge	Universal axioms and principles: terminology, facts, specifics, conventions, and criteria. The ability to remember (recall) previously learned materials. Arranges, defines, describes, duplicates, identifies, knows, labels, lists, matches, memorizes, names, outlines, recalls, recognizes, repeats, reproduces, selects, states.
Comprehension	Use of material in a form different from the way it was learned, i.e., translation, interpretation, extrapolation.
Application	Problem solving and the ability to do case study.
Analysis	Elements and relations of organizational principles: an ability to break down a situation into its parts.
Synthesis	Production of a unique communication which puts a field in a broader context, production of a plan or set of objectives.
Evaluation	Good or bad, workable, helpful, etc.? What values does it uphold? Internal vs. external evidence.

Our learning effectiveness rating procedure was designed to minimize subjectivity. The procedure used a scale (Figure 3) with clearly anchored definitions for each of three rating

categories. The scale links ratings to the degree and direction of statistical difference between treatment (DL) and control group learning outcomes as reported in each of the 15 studies. If studies showed significant differences in favor of control group learning outcomes, a rating of 1 was assigned. If no statistical differences resulted between treatment and control groups, a rating of 2 was assigned. Where differences were reported in favor of the DL treatment group(s) as compared to the control group, a rating of 3 was assigned. While this scale does not provide fine gradations for differences in learning outcomes, it is clearly linked to the degree of between-group differences and eliminates evaluator bias in arriving at ratings.

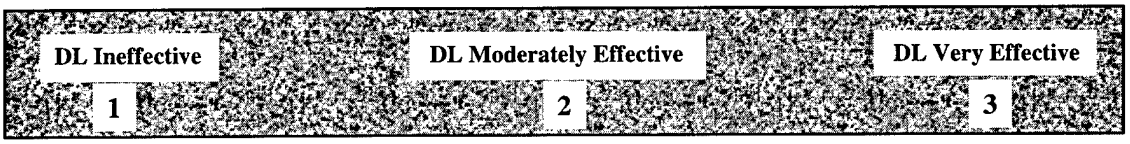

Figure 3. Likert Scale used to Rate Learning Outcome Effectiveness for the Studies

The preliminary summary matrix used to classify DL studies is shown in Table 5. It consists of DL methods/media along the vertical axis and skill/knowledge types listed horizontally. This classification scheme was developed iteratively with ARI review/inputs.

After populating the Table 5 matrix with studies, many cells were eliminated due to the absence of studies applicable to those media x skill/knowledge types. For example, although there is strong interest in digital battlefield skills/knowledge, no study directly addresses digital proficiency training. Other cells were combined (i.e., CMC and CBT) into a single category. The learning effectiveness data were used to produce histograms of rating frequencies for each applicable cell. That "raw data" matrix is included in Appendix C and summarized in Table 6.

Table 5 studies were reviewed against all possible skill/knowledge x method/media combinations, then assigned to all applicable cells with a reference number. For example, if a study assessed higher-order cognitive skills using video teletraining (VTT), its reference number was assigned to the applicable cell (VTT x Cognitive). If the study also appeared to include procedural skills, the same study reference number was assigned to the applicable cell (VTT x Procedural).

Table 5.
Preliminary Matrix for Classifying Studies

Methods/ Media	Types of Learning							
	Declarative	Narrative/ Descriptive	Hands-on/ Perceptual-Motor	Procedural	Cognitive	Leadership	Digital	Affective
Audio								
Video								
CBT								
Collaborative Technologies								
Computer-Mediated Conferencing								
Intelligent Tutoring Systems								
Printed Materials								
Web-based Environments								

Only one Table 6 cell (Audio x Perceptual-Motor) yielded a modal rating of 3 (DL learning outcomes statistically superior to controls) and that was based on a very small sample (n=3). All other ratings are in the 2 category indicating that DL-trained groups learn as well as controls. This is consistent with Russell's (1999) "no significant difference" finding.

Table 6.
Documented DL Technology Effectiveness for Training Skill/Knowledge Types

	Declarative	Perceptual-Motor	Procedural	Cognitive	Leadership
Audio	**Overall Rating 2 ES ?**	**Overall Rating 3 ES Medium**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES Medium**
Study No.	*14*	*14, 15*	*5, 14, 15*	*4, 6, 14, 15*	*4*
Video	**Overall Rating 2 ES Low**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES ?**
Study No.	*9*	*2, 3, 8, 10, 11, 12, 13*	*1, 2, 3, 5, 7, 10, 11, 12, 13*	*1, 2, 4, 5, 7, 9, 10, 11, 13*	*1, 2, 4, 9, 12, 13*
CMC/CBT	**Overall Rating ES**	**Overall Rating ES**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES ?**	**Overall Rating 2 ES ?**
Study No.			*6, 12, 13*	*6, 12, 13*	*14*

Figure 4 shows the frequencies of ratings within each category for pooled Table 6 results. The majority of the ratings (77%) were in the "no significant difference" (2) category. Where learning differences were found, DL-trained groups performed better than control groups (Category 3).

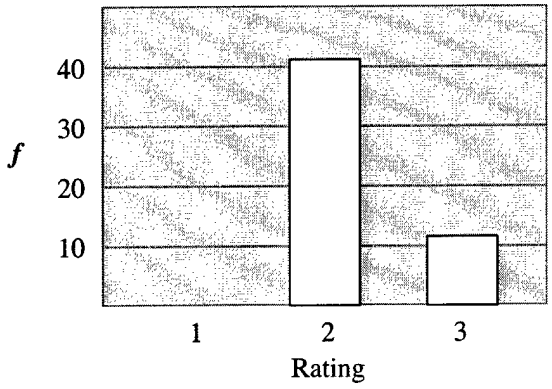

Figure 4. Frequency Distribution of Learning Effectiveness Ratings

In addition to the ratings of effectiveness, we used Cohen's (1969) technique to compute Effect Sizes (ES) for each study reporting standard deviations.

The ES is an estimate of the treatment effect and is computed by:

$$\frac{\overline{X}_{DL} - \overline{X}_{C}}{\text{Pooled SD}}$$

where $\overline{X}_{DL}$ = Mean of DL group measure
$\overline{X}_{C}$ = Mean of control group measure

and Pooled Standard Deviation (SD) can represent either group since they are assumed to be equal (Cohen, 1969).

Unfortunately, only 5 of the 15 studies in Figure 2 included sufficient data to compute the ES. Using Cohen's guidelines, we categorized ES strength as follows:

Small	0.50
Medium	0.51-0.79
Large	>0.79

One study (2) reported SDs very small and nearly identical (overall SDs = 0.018-0.025) for treatment and control group measures. For this study, mean test score differences were only a few percentage points. Although the small SDs produced a large ES (5.9), there were no

statistically significant differences in learning outcomes between the groups. This ES therefore is not included in Table 6.

Table 6 results suggest that medium overall ES were found for audio DL media in training perceptual-motor and leadership skills. A low ES resulted for the single Video x Declarative study. No other ES conclusions are defensible.

CURRENT PROGRAMS

Following is a brief synopsis of DL programs and initiatives impacting those of the Army's. The plans have common elements, but different focal areas and missions depending on the training needs of the organization.

Advanced Distributed Learning

Perhaps the most significant industry-wide DL initiative, the Advanced Distributed Learning (ADL) program, is designed to encompass virtually all DL-requirements for the Services, industry, academia, and the public sector. The principal current focal area for DL is the development and use of Reusable Content Objects (RCOs), Reusable Learning Objects (RLOs), and Knowledge Objects (KOs). The ADL initiative, launched in 1997 and cultivated by the DoD and the White House Office of Science and Technology, is aimed at the widespread dissemination of reusable content via Sharable Courseware Object Reference Model (SCORM) standards and guidelines. SCORM ensures that learners have access to standard, yet adaptable, education and training when and where it is needed using PC platforms. ADL will streamline the Instructional Systems Development (ISD) process without compromising the integrity or effectiveness of emerging instruction. ADL now uses "plugfests" to test the viability of the content as well as delivery speed and accuracy. ADL success hinges on the cost and learning effectiveness of emerging hardware and software products. Operational measures of success will need to be linked to the ADL elements. Further ADL information can be found at http://www.adlnet.org. Additionally, Parmentier, Fletcher, Jesukiewicz, and Dodds (2000) provide a useful description of ADL history, status, and projections.

Naval Postgraduate School

The DL Migration Plan for the Naval Postgraduate School (NPS) can be reviewed at http://web.nps.navy.mil/dlrc/NPS_plan/. The plan is designed to provide easy access to education and information for all Navy officers anytime and anywhere. Extensive revisions to the curricula

and content are being made to achieve this goal. A vision of the future war is driving this effort. Some changes include interdisciplinary emphasis, integrating academics with military education, and incorporating new information technologies for delivering selected instructional materials. The Warrior Curriculum addresses the need to establish a foundation of interdisciplinary technical skills with a concentration of military applications of information technology. The NPS will offer a broad spectrum of courses that are especially designed to raise the educational levels of officers in support of the war-fighting requirements during the next decade. The mission is reflected in the operational motto, "from technical to tactical". To facilitate its DL requirements, NPS will capitalize on multimedia, high-capacity storage media, broad bandwidth telecommunications, intranets and the Internet, and other methods designed to enhance student learning. Some key objectives of this program are:

- Provide residential programs, as required
- Provide on- and off-campus instruction using traditional methods/media
- Offer off-campus video tele-education programs
- Offer on- and off-campus instruction using portable media (CDs and DVD)
- Provide off-campus instruction using telecommunication technologies (Internet and videoconference)
- Facilitate off-campus access to libraries via electronic media

The migration plan provides a methodology for assessing existing and planned courses regarding appropriateness for conversion/development in DL formats. For courses to be converted to DL, the plan provides guidelines to technologies and criteria for evaluating their effectiveness. A recommended migration process with a timeline is included as well as a DL business model. The NPS model is designed to fully exploit and accommodate the ADL initiative.

The Air Force DL Plan

Two major factors have driven DL within the Air Force—the need to make content readily available to approximately 390,000 learners located worldwide and the demands to lower training delivery costs per learner. The Air University reported savings of $700 per student using satellite technology. CD-ROMs replaced 25 volumes of text to support a correspondence course resulting in a savings of $364,000 per year. CBT allowed learners to complete the course in one-

fourth of the time of resident enrollment and increased enrollment by almost 500% (Cherry, 1996).

The Air Force Institute of Technology (AFIT) located at Wright-Patterson AFB, OH, provides a full curriculum of master and doctorate degrees, mainly in math and sciences. AFIT offers more than 20 continuing education programs using two-way audio and video teletraining via the Air Technology Network (ATN) and the Government Education and Training Network (GETN). ATN uses digital video and audioconferencing for two-way audio interaction and reaches 87 worldwide sites (Westfall, 1999). For 2000, approximately 9,000 hours of DL were delivered using ATN and GETN.

The Air Force Distance Learning Office (AFDLO) has designed its DL initiatives around the following areas of concern:

- Customer and provider needs identification
- Policies and standards linked to AF requirements
- Information dissemination throughout the AF
- Data collection, analysis, and comprehensive reporting
- Administrative requirements for tracking student and DL courseware data
- Scheduling and coordination of the Air Technology Network for delivery
- Assigning program managers and manpower for ATN management

Information on the Air Force Institute for Advanced Distributed Learning is available at http://www.au.af.mil/au/afiadl.

CONCERNS AND CAVEATS

TRW has provided a DL research product that is in compliance with our Statement of Work. Two concerns apply to the use of the Table 6 matrix for assessing DL effectiveness. First, it provides a somewhat over-simplified, two-dimensional view of a complex issue (DL effectiveness). The literature is clear on the multidimensional nature of DL. The prevailing view is that DL effectiveness stems not from methods/media/technology, but from a conscientious and deliberate attempt to design, develop, deliver, manage, and evaluate instruction from a systems viewpoint. According to Clark (1983),

> *"...the best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement*

(learning outcomes) any more than the truck that delivers our groceries causes changes in our nutrition."

Clark (1983) further states that:

"...media are still advocated for their ability to increase learning when research clearly indicates that such benefits are not forthcoming. Of course such conclusions are disseminated slowly and must compete with advertising budgets of the multi-million dollar industry which has a vested interest in selling machines."

While the above comments were published well before the advent of the Internet, they are perhaps even more valid now than nearly two decades ago. Guice (1997) has indicated that virtual classrooms have not sufficiently addressed social and educational questions. He states that,

"...too much attention is focused on hardware and software. Too little attention is invested in how the technologies are to be used, and how media affect the experiences that students have. Many leading efforts now attempt to put people and learning, rather than technology in itself, at the center of attention."

Joy and Garcia (2000) indicate that practitioners should not assume that students learn better from technology-based systems, but rather that instructional design strategies control learning effectiveness, regardless of medium. They examine five randomly chosen studies and report significant design flaws in each of them.

Our second concern lies with assigning ratings to skill/knowledge type based solely on a review of the study methodology. Some studies include very sketchy information on the specific types of skills/knowledge addressed, leaving the reader to infer skill/knowledge types from brief generic descriptions of the course(s). For example, Study 10 (Wetzel, 1996) lists a Celestial Navigation course as one of the targeted topics for DL effectiveness assessments. The study, however, provides no description of the specific knowledge or performance requirements for the course. To attenuate concerns based on incomplete information in many of the studies, we decided to devise a rating procedure that minimizes subjectivity. Our procedure used a Likert scale with clearly anchored definitions for each rating category. The scale, shown in Figure 3, links ratings to the degree and direction of statistical difference between treatment (DL) and control group learning outcomes as reported in each study.

Finally, in regard to experimental design issues, it should be noted that DL studies can unintentionally bias study conditions by using more resources, more highly motivated

instructors, mentoring/coaching, greater incentives for learners, or better planning for DL treatment groups as compared to the control groups. There should be concerted efforts to ensure a match between learning objectives and outcome tests of those objectives. Ironically, in attempting to address the very issues that make DL more effective and efficient, we may confound DL delivery in favor of the treatment group, thereby leading to misinterpretation of results.

CONCLUSIONS

Table 6 data are useful for summarizing the categories of methods/media that are currently used to train the various DL skill/knowledge types. However, the matrix does not offer practical help for assigning media to skill/knowledge types because ratings and effect sizes are not discriminators in the classification scheme. It is therefore intended as a tool that can be used to incorporate additional factors (e.g., cost, resource use, user acceptability, technical constraints) as the DL database grows. Indeed, a multidimensional matrix that allows users to query the database relative to the DL variable of interest should be a goal. An electronic wizard that provides quantitative and qualitative guidance on the design of DL environments is one outgrowth of such a goal.

Consistent with Russell's (1999) results, Table 6 ratings indicate that the DL media employed within empirical investigations are statistically as effective as conventional training in producing the desired learning outcomes. This suggests that, in addition to its more widely disseminated efficiency benefits, DL is promising for achieving learning effectiveness. But it is not the DL media that yield the effectiveness. *When employed with sound instructional design, purposeful mentoring and guidance by instructors, and a genuine desire on the part of students to learn, DL will likely be successful.* The literature clearly supports this conclusion (Clark, 1983; Clark and Salomon, 1986; Phipps and Merisotis, 1999; Wisher et al., 1999; Machtmes and Asher 2000; and Champagne and Wisher, 2000). Regardless of whether students are separated by teaching sources in space or time, decisions about the use of various training media should be made on the basis of factors other than learning effectiveness. Instructors must feel comfortable with their role in guiding learners through the DL process to reduce attrition and facilitate learning (Carr, 2000). Learner-centered approaches link training content to the needs and

experience of the learners (Hannafin and Land, 1997). However, such approaches are seldom possible in military settings.

Although empirical in nature, Table 6 studies generally lack statistical detail required to calculate accurate estimates of effect sizes. The evaluation factors included in Figure 2 are recommended as guidelines for designing and conducting effective DL.

The Advanced Distributed Learning program is expected to standardize DL requirements for the military services as well as industry, academia, and the public sector. As the ADL program becomes more mature and standardized, more valid comparisons of DL attributes should be possible.

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APPENDIX A – NON-EMPIRICAL DL RESEARCH SUMMARY

NON-EMPIRICAL DL RESEARCH SUMMARY

Author/Reference	Summary
Alexander (1999)	This article describes a "collaborative instructional design project using constructivist theory, exploratory and resource-based learning, electronic communities, and integrated information technology immersion." Learning outcomes for student and faculty participants in a graduate health services planning and policy course are discussed and analyzed.
Bond & Pugh (2000)	This paper describes distance learning training attempts for two Army National Guard courses: Air Traffic Control and Helicopter Maintenance. General lessons learned are noted.
Bonk & Wisher (2000)	Research that adapts and evaluates new collaborative and e-learning tools in Army settings can determine whether the benefits of innovative approaches to education can also benefit training. This article recommends ten primary experiments to serve as a research framework to adapt and tailor e-learning technologies to Army training needs.
Brown (1996)	The Army Distance Learning Plan addresses DL applications and directs major commands to develop DL plans to meet their training requirements. The Medical Command's U.S. Army Medical Department DL Plan, addresses the overall requirements of DL application for medical training. As a result of this progression, conversion of combat medical training into distance learning format has become a priority for continued readiness in the U.S. Army Medical Department.
Brown & Wack (1999)	The authors question/critique the report "What's the Difference?" (Phipps and Merisotis, 1999), prepared by The Institute for Higher Education Policy. The authors conclude that, while more and better assessment of distance learning is needed, what's needed even more is for that research to inform practice.
Buscho & Knutson (1999)	This paper describes the Advisor Learning Network provided for American Express Financial Advisors. Extensive training is provided on a wide variety of topics using a variety of methods.
Calder (2000)	Regarding the development and provision of best practice and the place of critical reflection by stakeholders, this article considers what some contributors to the literature on open and distance learning have to say.
Champagne & Wisher (2000)	Provides the practitioner with an understanding of the essential elements of a beneficial evaluation, with an emphasis on considerations for evaluation design.

Author/Reference	Summary
Champagne, Wisher, Pawluk, & Curnow (1999)	This paper presents a critical review of empirical studies designed to compare training by distance learning technologies to training by traditional classroom instruction.
Crawford & Suchan (1996)	This report addresses the use of instructional media in teaching executive management education. The research proposes four learning outcomes and examines them in the context of the instructional techniques required to support them.
Cyrs (1997)	The authors of the book are among those who believe that distance education is the future of education, and institutions that will survive are those who use the technology to deliver programs that are convenient and cost-effective for learners. Timely explanations for experienced distance teachers and practitioners offer rich information about skills needed for distance education.
Despain (1997)	This study addressed the integration of computer-delivered listening comprehension exercises into the university-level foreign language curriculum. Results suggest that students tend to learn more effectively/efficiently using the computer delivery system.
Dodge, Webb, & Christ (1999)	This report reviews and analyzes the individual and collective effects of information technology as presented in the management science and business literature. The goal of the report was to address the impact of information technology on the human dimensions of battle command.
Douzenis (1998)	The purpose of the study presented in this paper was to determine the relationship between cognitive style and achievement in a master's level educational research course taught using distance education technology. Results of the study demonstrated a relationship between cognitive style measures and achievement in a distance education course. However, only 20% of the variance in achievement was explained by these variables. Limitations of this study include a small sample size and measurement of achievement in only one course subject (educational research).
Goldberg (1997)	This paper describes an experiment evaluating Web-based course delivery in terms of academic performance and student acceptance. Students in a third-year university computer science course were divided into three groups (Web only, lecture only, and combined Web/lecture). In general, the Web-only delivery was equally successful compared to the lecture-only delivery. On average, students in the combined lecture/Web delivery group performed academically better than students in the other group.

Author/Reference	Summary
Green (1997)	"Begun in 1990, the annual Campus Computing Project is the largest continuing study of information technology in American higher education." The 1999 survey data were provided by campus officials (typically the senior technology officer) at 557 2- and 4-year public and private colleges and universities in the U.S.
Guice (1997)	This article describes and evaluates a seminar course taught jointly between Stanford University and Sweden's Royal Institute of Technology using videoconferencing over the Internet. The author reports that curriculum and instructional design are more important than technology for distance learning success.
Hassen, Wieckhorst, Madden, Franz, & Dunlap (1996)	This report documents the structured approach developed for reviewing formal Navy courses to identify opportunities to reduce training time and costs through the application of advanced training technologies. This effort was complicated by the "unmanageably large numbers" of courses to be reviewed. The Training Delivery Assessment Model (TRADAM) performed extremely well during training efficiency review of 40 formal training courses.
Hiltz, Coppola, Rotter, Turoff, & Benbunan-Fich (2000)	This paper describes three studies (field study, field experiment, and semi-structured interviews) that address the importance of collaborative learning strategies to the success of ALN for students. A study of 26 courses, part of an undergraduate Information Systems program, compared the process and outcomes of learning using an on-line anytime/anywhere environment to those sections taught in the classroom. Results support the premise that when students are actively involved in collaborative (group) learning on-line, the outcomes are as good as or better than those for traditional classes. But when students are just receiving posted material and returning individual work, the results are poorer than that for classrooms.
Jewett (1997)	This report is one of a series from a project entitled *Case Studies in Evaluating the Benefits and Costs of Mediated Instruction and Distributed Learning*. The subject of the case study is a graduate level certificate program in human computer interaction. All courses are new and designed for delivery in a distributed learning environment. For the course evaluated, there was little variation among final grades for students enrolled in the three modes (on campus, videoconferencing groups, and videotape groups.)

Author/Reference	Summary
Jewett (1998a)	This report is one of a series from a project entitled *Case Studies in Evaluating the Benefits and Costs of Mediated Instruction and Distributed Learning*. The University of Akron and Cleveland State University are offering a joint graduate program leading to the Master of Social Work degree using interactive videoconferencing. There is no evidence of a difference in learning outcomes (measured by grades) for students at the sending or receiving sites.
Jewett (1998b)	This report is one of a series from a project entitled *Case Studies in Evaluating the Benefits and Costs of Mediated Instruction and Distributed Learning*. A philosophy course was redesigned using a combination of synchronous/asynchronous methods. One section was taught in the "interactive web-based mode" and the other section was taught in a more traditional large lecture/small discussion format. Evidence regarding learning outcomes is "somewhat ambiguous." A microbiology course was restructured to improve student access to course-related materials and to improve communications between students and faculty and among students (bottom row at right). This was accomplished through the creation of an elaborate course Web site created to allow student access to class announcements, documents, practice exams, chat rooms, message boards, etc. The grades provided no evidence that learning outcomes changed as a result of the network technology (Web site). (Goal of redesign was to improve communication, not to change grades.)
Johns (1999)	This paper demonstrates 3-D practice environments developed to teach mechanical skills. The entire multi-layered application can be delivered via Web browsers on a corporate LAN or on the Internet.
Jones & Paolucci (1998)	The authors estimate that less than 5% of published research is sufficiently empirical, quantitative, and valid to support conclusions with respect to the effectiveness of technology in educational learning outcomes. The authors conclude with a call for further research concentrating on the application of appropriate technologies to the learning outcomes of the subject matter to which technology is applied.
Joy & Garcia (2000)	This paper outlines the philosophical positions of the opposing sides in the literature as to whether delivery media alone influences learning outcomes. Several representative media comparison studies were selected at random to illustrate the inadequacy of their methodologies and conclusions. ALN practitioners should adhere to time-tested instruction design strategies, regardless of the medium chosen.

Author/Reference	Summary
Kribs & Mark (1998)	The objective of this demonstration project was to determine whether VTT technology could be integrated with automated electronic classroom (AEC) technology to deliver computer-based performance training. The results indicate that the combination of VTT and AEC can be used to successfully deliver computer-based performance instruction.
Kronholm, Wisher, Curnow, & Poker (1999)	This paper describes the steps being taken to transform the advertising, scheduling, enrollment, and evaluation of satellite-delivered, short-term training from dependence on the telephone, fax, mail, and paper and pencil forms to reliance on the Internet as a value-added resource.
Leh (1999)	This paper examines research conducted on computer-mediated communication (CMC) in foreign language learning. The study revealed that CMC was beneficial for distance learning. A follow-up study was conducted 1 year after the initial study was completed. The results of the follow-up study supported the findings.
Lewis, Snow, Farris, & Levin (1999)	This report presents findings from the second nationally representative survey of distance education undertaken by the National Center for Educational Statistics. The survey collected information about the 12-month 1997-98 academic year. This report provides trend information for higher education institutions, including changes in the percentage of institutions offering distance education courses, enrollments and course offerings, degree and certificate programs, and technologies used to deliver distance education courses.
Liu & Ginther (1999)	This paper addresses the issue of adapting the design of distance education to students' cognitive styles.
Mitchell (1996)	This paper examines the concept and theory of distance learning, briefly traces the history of its development, and describes technology currently available. The paper discusses issues of quality and institutional planning and management and suggests some potential applications at the Army War College. Through distance learning, the Army War College core missions can be enhanced to meet the challenges of increased need for strategic knowledge at all levels, limited or declining resources, and the changing needs of students.
Navarro & Shoemaker (2000)	This article describes a study of several hundred students in an introductory economics course. The cyberlearners learned as well as, or better than, traditional learners, regardless of such characteristics as ethnicity, gender, computer skills, and academic background/aptitude.

Author/Reference	Summary
Neal (1997)	This paper describes how collaborative learning technologies can be used to teach classes to geographically dispersed participants. The paper covers the motivation for virtual classrooms, the selection and use of delivery technologies, deployment strategies and issues, participant feedback, and the Virtual University that evolved from the initial distance learning classes. The study found that the use of a variety of collaborative technologies accommodated the multiple aspects of communication in the class.
Neal & Ingram (2000)	This paper describes the use of Lotus LearningSpace to teach an asynchronous distance learning class on human-computer interaction in a corporate setting. Approaches are needed that will manage both teachers' and learners' expectations about asynchronous instruction, while highlighting the advantages of this delivery method, as well as methods and strategies that will enable teachers to more effectively develop courses for asynchronous delivery.
Oblinger & Maruyama (1996)	The information in this paper captures "the rationale for the growing movement to deploy networking technologies strategically in instruction." The authors "articulate the need for higher education to create affordable and flexible student-centered 'distributed learning environments' which differ in fundamental ways from today's teacher-centered classrooms."
Ory, Bullock, & Burnaska (1997)	This paper presents the results of an investigation of male and female student use of and attitudes about ALN after one year of implementation in a university setting. Results of the study revealed no significant gender differences.
Parker (1999)	A need exists for research to determine predictors of dropout from distance education since attrition rates in distance education far exceed rates in classes taught in a traditional format. The results of the study presented in this paper are important as counselors and faculty now have a basis on which to advise students either into traditional or distance formatted courses for best possible completion.
Perraton (2000)	This paper advances four propositions about the links between theory and good practice and follows the propositions with four proposals about important areas of research.

Author/Reference	Summary
Phipps & Merisotis (1999)	The Institute was commissioned by the American Federation of Teachers and the National Education Association to review the current research on the effectiveness of distance education and to analyze what the research says and does not say. The report suggests that too many of the questions posed are left unaddressed or unanswered in the research.
Phipps, Wellman, & Merisotis (1998)	The authors were commissioned to "investigate the emerging topic of quality assurance in technology-mediated distance learning programs in higher education."
Rossman (1999)	A document analysis of more than 3,000 course evaluations from 154 courses conducted during 11 quarters was conducted. Narrative responses from course folders were grouped into categories. General observations related to the categories were presented, followed by several tips for successful teaching in an online environment using an asynchronous learner discussion forum.
Saba (2000)	The purpose of this article is to present a "coherent view of the state of research in distance education." The studies revealed the "complexity of distance education, indicating the many variables involved in any instructional setting..."
Schär, Schluep, Schierz, & Krueger (2000)	Five experiments were performed in order to investigate the effect of the computer user-interface on learning performance. The theoretical motivation was to validate the relevance of a cognitive theory about two modes of learning in a human-computer interaction context. The experiments showed consistently that the two learning modes can be induced by different user-interfaces, and that the induced learning mode has an effect on the learning performance.
Schutte (1996)	This report describes two methods used to present a social statistics class: traditional classroom and on the World Wide Web (virtual class). The virtual class scored an average of 20% higher than the traditional class on examinations.
Stoney & Oliver (1999)	The study outlined in this paper was part of a larger study that examined the use of interactive multimedia (multimedia microworld) in motivating and engaging adult learners. The study found that using a microworld meant that more emphasis was placed on the acquisition of higher-order thinking and problem-solving skills, with less emphasis placed on the assimilation of a large body of isolated facts.

Author/Reference	Summary
Stouffer (1998)	The major elements of information that senior managers need to know in planning distributed training are the cornerstone of the database. A significant amount of information has been compiled in the database, enabling it to answer specific training-related questions: How much goes on where? With whom? To what end? With additional budget-related data, the database could be a powerful informational tool.
Strauss & Frost (1999)	Nine key factors influence instructional technology media selection at the university. After describing various dimensions of the factors, the authors present two conceptual guides to assist in selecting technology for marketing classes, focusing on cognitive and skill-based learning objectives.
Summerville (1999)	The focus of this article was to examine the variables of cognitive style, subject awareness of the instructional implications of cognitive style, and matching/mismatching subjects with cognitive style. These variables may be important in the design of instructional environments, such as hypermedia, adapted to accommodate individual differences.
Thach (1996)	Defines distance learning and associated terms and explains its benefits. Describes how to get started beginning with the analysis phase and moving through the instructional design process, who should be involved in the development team, delivery tips, and evaluation methods. Job aid is an ROI worksheet.
Throne & Lickteig (1997)	The bibliography assembles available literature on computer skills training from commercial, educational, and military domains. The review consolidates the referenced literature by extracting key lessons learned categorized by the acquisition, retention, and transfer of computer skills.
Trindale, Carmo, & Bidarra (2000)	This article presents a selection of examples that, in the authors' words, "the chosen cases" should not be "considered as clearly better than any other one, nor missing cases be interpreted as lack of appreciation or a negative judgement."
Wagner (2000)	The paper suggests that emerging e-learning models will increasingly be based on a reusable learning object architecture paradigm.

Author/Reference	Summary
Walsh, Gibson, Miller, Hsieh, Gettman, & Newcomb (1996)	The reported research effort focused on the impact of distance learning on the curriculum, types of student-instructor interaction, student interaction with the instructional materials, and on the preparation of faculty and staff for conducting distance learning. The report also details the development, composition, and distribution of a distance learning survey and summarizes the results associated with the data analysis.
Walters & Reed (1997)	The report describes two methods used to present an introductory computing class: conventional lectures/laboratories and independent study. Results based on pre- and post-testing of both groups show that independent study students performed as well as those in the lecture course.
Wegner, Holloway, & Garton (1999)	Graduate students in a curriculum design and evaluation course were involved in a two-semester study of the effects of distance learning on student achievement. No significant differences between the test scores of the Internet-based test group and in-class group were found.
Wisher (2000)	This paper examines the following issues: how well soldiers can learn through distance learning technologies, the special requirements for measuring performance, limiting factors, and updating training policies.
Wisher & Curnow (1998)	This report describes an approach to creating a simplified form for evaluating the relevance and effectiveness of a distance learning event (defined as a training or educational program occurring within 1 day).
Wisher, Sabol, & Ellis (1999)	This report reviews what is known about forgetting as it applies to military tasks, concentrating on major projects by the U.S. Army Research Institute. This review makes clear several ways that the Army can minimize, or reverse, the effects of forgetting.
Wisher, Champagne, Pawluk, Eaton, Thornton, & Curnow (1999)	This report offers a review of the literature on the effectiveness of distance learning as applied to training. An assessment of the experimental designs, reporting, and interpretability of the findings was needed as previous reviews focused on whether there was "no significant difference" between distance learning and classroom comparison groups. The authors found that the research literature "focused on education rather than training, was largely anecdotal, and when effectiveness was examined, it was not supported by strong experimental or quasi-experimental design."

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APPENDIX B – DEFINITIONS AND GLOSSARY

METHODS AND MEDIA

Method/Media	Definition/Delivery Method
Audio	Delivered over cassette players, PCs, telephone, radio, or Internet: audio cassettes/conferencing/teletraining, CD-ROM, radio broadcast, streaming audio, voice mail
CBT	Delivered through stand-alone training applications, audio and video: CD-ROM, computer peripherals, mass storage devices, printers, etc.
Collaborative Technologies	Two or more people working together through electronic means (student-to-student), group process, mentoring; asynchronous and synchronous
Computer-Mediated Conferencing	Delivered through computer networks: application sharing, audiographics, bulletin board, white board, and chat room and e-mail (instructor-to-student)
Intelligent Tutoring Systems (Computational Intelligence)	"Intelligent tutors represent advanced forms of cognitive technologies that use computational intelligence. They are designed to provide adaptive instruction to users in the effort to promote and develop expert-like problem-solving skills. ...very useful in reducing the time required by learners to acquire expert-like problem-solving skills that would normally take two to three times as long to develop using more traditional instructional approaches. ...one of the most important instructional techniques offered by an ITS tutor is to assess the student's readiness to learn and then to bring to the student's awareness relevant prior knowledge and then to help clarify the relationship between the new and old learning: to understand the relationships that exist among concepts or principles that lead to better performance."[1]
Printed Materials	Delivered through mail, FAX, or Internet downloads: correspondence study, training manuals, study guides
Video	Delivered over videocassette players, PC, satellite, microwave, fiber optic, cable, telephone, or Internet: teletraining, CD-ROM, DVD, streaming video; videocassette
Web-based Environments	1-way video, 1-way audio; 2-way video, 2-way audio; CD-ROM; DVD; streaming video

[1] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

LEARNING STYLES

Learning Style	Definition/Examples
Affective Learning (Bloom's Taxonomy)[2,3]	Demonstrated by behaviors indicating attitudes of awareness, interest, attention, concern, and responsibility; ability to listen and respond in interaction with others; and ability to demonstrate those attitudinal characteristics or values which are appropriate to the test situation and the field of study. The five levels within this domain (with outcome-illustrating verbs) are listed below. (1) Receiving. The student's willingness to attend to particular stimuli. The instructor must be able to get, hold, and direct the student's attention. Learning outcomes range from the simple awareness that a thing exists to selective attention on the part of the learner. Asks, chooses, describes, erects, follows, gives, holds, identifies, locates, names, points to, replies, selects, sits, uses. (2) Responding. Active participation on the part of the student. They not only attend to a particular phenomenon, but also react to it in someway. Learning outcomes may emphasize compliance in responding, willingness to respond, or satisfaction in responding. The higher levels of responding include those in which the student shows interest. Answers, assists, complies, conforms, discusses, greets, helps, labels, performs, practices, presents, reads, recites, reports, selects, tells, writes. (3) Valuing. The worth or value a student attaches to a particular object, phenomenon, or behavior. This ranges from the simple acceptance of a value to the more complex level of commitment. Valuing is based on the internalization of a set of specified values, while clues to these values are expressed in the student's overt behavior and are clearly identifiable. Objectives dealing with students' attitudes and appreciation would fall into this category. Completes, describes, differentiates, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports, selects, shares, studies, works. (4) Organization. Contrasting different values, resolving conflicts between them, and organizing a unique value system. The emphasis is on comparing, relating, and synthesizing values. Learning outcomes may be concerned with the conceptualization of a value or with the organization of a value system. Adheres, alters, arranges, combines, compares, completes, defends, explains, generalizes, identifies, integrates, modifies, orders, organizes, prepares, relates, synthesizes.

[2] *Bloom's taxonomy*. http://www.tecweb.org/eddevel/blooms.html

[3] *Taxonomy of educational objectives*. http://www.usd.edu/admin/vpaa/assessment/taxonomies.html

Learning Style	Definition/Examples
	(5) Characterization by a Value or Value Complex. For a student to develop a characteristic life style, they must have a value system that controls their behavior. Thus, the behavior is pervasive, consistent, predictable, and most importantly, characteristic of the student. Instructional objectives are concerned with the student's general patterns of adjustment (personal, social, emotional). Acts, discriminates, displays, influences, listens, modifies, performs, practices, proposes, qualifies, questions, revises, serves, solves, uses, verifies.
Cognitive Learning Theory[4]	A general approach that views learning as an active mental process of acquiring, remembering, and using knowledge. Learning is evidenced by a change in knowledge which makes a change in behavior possible. Learning itself is not directly observable. *Types of memory:* • Sensory. The sensory register is a system of receptors which hold sensory information for a very brief period. Only things we want to remember will move into working memory. (Example: Sheila looks at the books on the shelf. For a brief second when she closes her eyes she can see an exact image of everything she saw.) • Working (a.k.a. short term memory). Information from the sensory register focused on at a given moment. Information can be held for approximately 20 seconds without maintenance rehearsal. (Example: Attempt to remember someone's name by saying "his name is William, William, William, William, William." As long as you say the name, it is in active use in working memory. The name is short enough to fit the limits of the articulatory loop (1.5 sec). • Long Term. The permanent store of information, virtually unlimited in capacity. Problems with recall lie in method of retrieval. (Example: You remember your telephone number because it is in your long-term memory.) *Types of knowledge:* • General. Information that is useful in many different kinds of tasks. Skills used both in and out of school. (Example: Knowing how to add and subtract and make change.) • Domain-Specific. Information that generally applies to only one situation. (Example: Knowing that a "roux" is a butter-and-flour mixture used in cooking.) • Declarative. Verbal information, lists of facts. Information that can be taught through lecture or acquired through books, verbal exchange, Braille, sign language, etc. (Example: When asked, you could give your address.)

[4] *Cognitive learning theory terms.* http://mse.byu.edu/ipt/ipt301/jordan/learnterm_c.html

Learning Style	Definition/Examples
	• Procedural. Knowledge that is demonstrated when we perform a task. (Example: Knowing what ingredients go into a cake (declarative knowledge) but how to combine them to make a cake is procedural knowledge.) • Conditional. Knowing when and why to use declarative and procedural knowledge. (Example: You may know what a Kokanee is (declarative) and you may know how to catch one (procedural) but knowing under what conditions you should fish—shallow or deep—is conditional knowledge.
Cognitive Learning (Knowledge Acquisition)[5,6,7,8]	Demonstrated by knowledge recall and the intellectual skills: comprehending information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and evaluating ideas or actions. This domain is predominant in the majority of courses. The six levels within this domain (with outcome-illustrating verbs) are listed below. (1) Knowledge. The ability to remember (recall) previously learned materials. Arranges, defines, describes, duplicates, identifies, knows, labels, lists, matches, memorizes, names, outlines, recalls, recognizes, repeats, reproduces, selects, states. (2) Comprehension. The ability to understand the meaning of informational materials. Classifies, comprehends, converts, defends, describes, distinguishes, estimates, explains, extends, generalizes, gives examples, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates. (3) Application. The ability to use previously learned material in new situations. Applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses. (4) Analysis. The ability to separate material into its component parts so that its organizational structure may be understood. Analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, points out, relates, selects, separates, subdivides. (5) Synthesis. The ability to put parts together to form a new whole, with an emphasis on the creation and formulation of new meanings, patterns, or structures. Categorizes, combines, compiles, composes,

[5] *Bloom's taxonomy.* http://www.tecweb.org/eddevel/blooms.html

[6] *Major categories in the taxonomy of educational objectives.* http://faculty.washingon.edu/~krumme/guides/bloom.html

[7] *Taxonomy of educational objectives.* http://www.usd.edu/admin/vpaa/assessment/taxonomies.html

[8] *Bloom's taxonomy, DLRN technology resource guide,* Chapter 4. http://gopher.fwl.org/tie/dlrn/blooms.html

Learning Style	Definition/Examples
	creates, designs, devises, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes. (6) Evaluation (highest level). The ability to judge the value of material for a given purpose using defined criteria. Appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.
Cognitive Task Analysis (CTA)	"...conducted to ensure that the software provides for effective instruction.... Using CTA approaches, it is possible for developers to accurately identify the knowledge and skills (employed by experts to solve problems) that will eventually be coded within the software program. Using structured knowledge-acquisition processes, CTA involves interviewing subject matter experts regarding the knowledge and skills used to solve problems in the domain. For example, using the PARI CTA method, the following questions are asked for each task, and related actions (or simple tasks), performed to achieve a goal: *Action:* • What would your first action be in solving this problem? • Are there prior steps you would have to take to perform the action (e.g., consult printed procedures?) *Precursor*: • Why are you taking this action? • What is your reason in terms of acquiring information you need to goals you're attempting to reach? *Result:* • What does the result of obtaining the information or feedback tell you regarding your actions? *Interpretation*: • On the basis of your results, what conclusions are you drawing? • What needs to be done next?"[9]
Declarative Knowledge	1. Knowledge that is acquired throughout the learner's lifetime. 2. First requires the learner to comprehend the meaning of incoming information. 3. Requires the learner to be able to relate new ideas to old.[10]

[9] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Cognitive task analysis*. http://citl-s2.tamu.edu/citlsite/cta.htm

[10] *Learning strategies*. http://uwf.edu/coehelp/club_id/lesson/strategy/acquire.htm

Learning Style	Definition/Examples
	Contrasted with procedural, conditional, or narrative knowledge, declarative knowledge is fundamentally "fact-based" knowledge. Declarative knowledge comprises discrete units of knowing, either very specific facts or generalities. For example, one can know or recall a telephone number (specific) and one can know that telephones are one type of communication device (general). Individual units of declarative knowledge can be linked or organized into larger units of knowledge; for example, wired telephones, cellular telephones, electronic mail, postal mail, and radios are common means for communicating with individuals. Declarative knowledge is regarded as "knowing that" something is the case.[11]
Digital	Primarily an Army classification, digital skills are those that support the operation, management, and control of digital (computer) systems for battlefield command, control, communication, and intelligence (C3I) superiority. At the most basic level, digital skills are required for setup, operation, and maintenance of the various equipment systems. At higher levels, digital skills are required for information processing and dissemination, situational awareness, decision making, and other cognitively-mediated requirements.
Leadership	There is no single definition of leadership that can encompass all the possible connotations. 1. Hanson supplies definitions which emphasize the role of people, processes, and systems in the leadership equation to varying degrees.[12] 2. Katz & Kahn consider the essence of leadership to be "the influential increment over and above mechanical compliance with the routine directives of the organization."[13] 3. Lipham writes of the inherent contradiction in most definitions of administrative leadership. "The administrator is concerned primarily with maintaining, rather than changing, established structures, procedures, or goals. Thus, the administrator may be viewed as a stabilizing force...We may define leadership as the initiation of a new structure for accomplishing [or changing] an organization's goals or objectives."[14] 4. Getzels argues that definitions describing the leader as one who

[11] Woolfolk, A. E. (1995). *Educational psychology*, 242. Needham Heights, MA: Allyn & Bacon.

[12] Hanson, E. M. (1991). *Educational administration and organizational behavior*, 183. Needham Heights, MA: Allyn & Bacon.

[13] Katz, D., & Kahn, R. (1996). *The social psychology of organizations* (2nd ed.), 302. New York, NY: John Wiley & Sons, Inc.

[14] Lipham, J. (1964). *Behavioral science and educational administration*, 122. Chicago, IL: The University of Chicago Press.

Learning Style	Definition/Examples
	initiates a new structure in the social systems, as many definitions do, are inadequate. He contends, "The missing ingredient is recognition that leadership depends on *followership*, a function of cooperation or mutuality *with* the leader rather than forcible domination and coercion *by* the leader." [15]. 5. Getzels, Lipham, and Campbell distinguish between superordination, where authority is granted to the individual by the institution, and leadership, where the authority is extended by the followers. The source of superordination lies in vested authority, whereas the source of leadership lies in entrusted authority.[16] 6. Kelly stresses that it is the group that attains goals and not the leader, and that "leadership is the performance of acts which assist the group in achieving certain ends."[17] 7. Boles and Davenport say that leadership is a process—not a category of behavior, a prerogative of position or personality, nor a collectivity of persons. "By our definition, leadership is a process in which an individual takes initiative to assist a group to move toward production goals that are acceptable, to maintain the group, and to dispose of these needs of individuals that impelled them to join it."[18]
Narrative/ Descriptive	A conception of one way in which the mind organizes knowledge. In the narrative mode, humans deal with experience by constructing stories and listening to the stories of others. It is contrasted with paradigmatic thought by Bruner: [paradigmatic thought] "deals in general causes, and their establishment, and makes use of procedures to assure verifiable reference and to test for empirical truth...the narrative mode leads instead to good stories, gripping drama, believable (although not necessarily 'true') historical accounts...It strives to...locate the experience in time and place."[19]
Hands-on/ Perceptual-Motor	Refers to the relationship between human movement and perceptions. Studies investigating the link between movement and perceptual development have been conducted with varying results.
Procedural Knowledge	"Knowing how" to do something such as divide fractions or clean a carburetor. Notice that repeating the rule "to divide fractions, insert the divisor and multiply" shows *declarative* knowledge—the student can

[15] Getzels, J. (1973). Theory and research on leadership: Some comments and alternatives. In Cunningham, Luvunr, and Gephart (Eds.), *Leadership: The science and art today*, 16. Itasca, IL: F. E. Peacock.

[16] Getzels, J., Lipham, J., & Campbell, R. (1968). *Educational administration as a social process*, 135-136. New York, NY: Harper & Row.

[17] Kelly, J. (1974). *Organizational behavior: An existential-systems approach*, 365. Homewood, IL: Richard D. Irwin, Inc.

[18] Boles, H., & Davenport, J. (1975). *Introduction to educational leadership*, 153. New York, NY: Harper & Row.

[19] Bruner, J. (1986). *Actual minds: Possible worlds*, 13. Cambridge, MA: Harvard University Press.

Learning Style	Definition/Examples
	state the rule. But to show *procedural* knowledge, the student must act. When faced with a fraction to divide, the student must divide correctly.[20]
Strategic	Directs knowledge, acquisition-procedures intentionally employed to overcome some deficit in performance or to regulate one's thinking or performance. A strategy can be considered a plan of action in which the sequence of the separate cognitive activities is laid down.[21]
Higher-Order Cognitive	Related to or involving cognition. Awareness, perception, reasoning and judgment are all aspects of cognition.[22] Cognitive science refers to the interdisciplinary study of the acquisition and use of knowledge. It includes as contributing disciplines: artificial intelligence, psychology, linguistics, philosophy, anthropology, neuroscience, and education. The cognitive science movement is far reaching and diverse, containing within it several viewpoints. Cognitive science grew out of three developments: the invention of computers and the attempts to design programs that could do the kinds of tasks that humans do; the development of information processing psychology where the goal was to specify the internal processing involved in perception, language, memory, and thought; and the development of the theory of generative grammar and related offshoots in linguistics. Cognitive science was a synthesis concerned with the kinds of knowledge that underlie human cognition, the details of human cognitive processing, and the computational modeling of those processes. There are five major topic areas in cognitive science: knowledge representation, language, learning, thinking, and perception.[23,24]

[20] Woolfolk, A. E. (1995). *Educational psychology*, 243. Needham Heights, MA: Allyn & Bacon.

[21] *Strategy/strategic knowledge.* http://www.library.www.edu/cbl/ray/knowledge-information/strategic_knowledge.htm

[22] *Dictionary.com.* http://www.dictionary.com/cgi-bin/dict.pl?term=cognitive

[23] *Cognitive science.* http://web.psych.ualberta.ca/~mike/Pearl_Street/Dictionary/contents/C/cognitive_science.html

[24] Eysenck, M. W. (Ed.) (1990). *The Blackwell dictionary of cognitive psychology.* Cambridge, MA: Basil Blackwell Ltd.

GLOSSARY

Analyzing Skills	Core thinking skills that involve clarifying information by examining parts and relationships. Identifying attributes and components (determining characteristics or the parts of something), identifying relationships and patterns (recognizing ways that elements are related), identifying main ideas (identifying the central element), and identifying errors (recognizing logical fallacies and other mistakes and, where possible, correcting them.[25]
Audioconferencing	More than two people or groups, in different locations, communicating by voice via a telecommunications network.[26]
Comprehending	Generating meaning or understanding.[27]
Computer-Based Training (CBT)	This term covers the same types of programs as computer-learning and computer-based learning but in a training context (i.e., computer programs designed to interface with the user in such a way as to stimulate an encounter between a trainer and a trainee). The term can refer to all forms of teaching programs, including tutorial dialogs and simulations.[28]
Computer-Mediated Conferencing	The computer equivalent of a telephone conference, whereby participants can exchange textual messages on a group basis. Such exchanges need not occur simultaneously (synchronous), but can occur over a period of hours, days, or even weeks, as time permits (asynchronous).[29]
Core Thinking Skills	Cognitive operations used in thinking processes.[30]
Creative Thinking	The ability to form new combinations of ideas to fulfill a need, or to get original or otherwise appropriate results by the criteria of the domain in question.[31] Original and appropriate thinking.[32]

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[25] *Thinking skills vocabulary and definitions*. http://www.adprima.com/thinkskl.htm

[26] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Glossary*. http://citl-s2.tamu.edu/citlsite/citl-glossary-main.htm

[27] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

[28] *Bloom's taxonomy*. http://www.tecweb.org/eddevel/blooms.html

[29] Ibid.

[30] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

[31] Ibid.

[32] Ibid.

Critical Thinking	Reasonable, reflective thinking that is focused on deciding what to believe or do. Critical thinkers try to be aware of their own biases, to be objective and logical.[33]
Declarative	Knowledge or factual information.[34]
Knowledge	Stored information that is acquired throughout the learner's lifetime that first requires the learner to comprehend the meaning of incoming information and requires the learner to be able to relate new ideas to old.[35]
Effect Size	A standard deviation, or Z score, with a range from about -3.00 to +3.00. A study with no difference between the treatment and control groups would have an effect size of 0. Any effect size greater than 0.50 is considered a major difference, and a 0.20 to 0.50 effect size is considered important.[36]
Encoding Skills	Remembering skills that involve storing information in long-term memory.[37]
Evaluating (as applied to metacognition)	Assessing one's current knowledge state[38]
Evaluating Skills	Core thinking skills that involve assessing the reasonableness and quality of ideas. Establishing criteria (setting standards for making judgments) and verifying (confirming the accuracy of claims).[39]
Focusing Skills	Core thinking skills that involve selected pieces of information and ignoring others. Defining problems (clarifying needs, discrepancies, or puzzling situations), and setting goals (establishing direction and purpose).[40]

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[33] Ibid.

[34] *Bloom's taxonomy*. http://www.tecweb.org/eddevel/blooms.html

[35] *Learning strategies*. http://uwf.edu/coehelp/club_id/lesson/strategy/acquire.htm

[36] Machtmes, K., & Asher, J. W. (2000). A meta-analysis of the effectiveness of telecourses in distance education. *The American Journal of Distance Education*, 14, 1.

[37] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

[38] Ibid.

[39] Ibid.

[40] Ibid.

Generating Skills	Core thinking skills that involve producing new information, meaning, or ideas. Inferring (going beyond available information to identify what may reasonably be true), predicting (anticipating next events or the outcome of a situation), and elaborating (explaining by adding details, examples, or other relevant information).[41]
Information-Gathering Skills	Core thinking skills that involving bringing to consciousness the relevant data needed for cognitive processing. Observing (obtaining information through one or more senses) and formulating questions (seeing new information through inquiry).[42]
Integrating Skills	Core skills that involve connecting or combining information. Summarizing (combining information efficiently into a cohesive statement) and restructuring (changing existing knowledge structures to incorporate new information).[43]
Intelligent Tutoring System	Computer systems that combine cognitive models with techniques from artificial intelligence to create instructional interactions with students.[44]
Learning Objective	The component actions, knowledge, and skills that students must learn if they are to attain mastery. Learning objectives represent the learning difference between where the learner is now and where one wants them to be.[45]
Metacognition	Knowledge about our own thinking. Planning how much time to allocate to a certain task, monitoring how well we are doing and if we should change strategies, and evaluating our efforts to see if we have done an adequate job.[46] A dimension of thinking that involves control of self and knowledge and control of process.[47] Awareness and control of one's thinking, including commitment, attitudes, and attention.[48]

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[41] Ibid.

[42] Ibid.

[43] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

[44] *Bloom's taxonomy*. http://www.tecweb.org/eddevel/blooms.html

[45] Ibid.

[46] *Cognitive learning theory terms*. http://mse.byu.edu/ipt/ipt301/jordan/learnterm_c.html

[47] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

[48] Ibid.

Organizing Skills	Core thinking skills that involve arranging information so that it can be used more effectively. Comparing (noting similarities and differences between or among entities), classifying (grouping and labeling entities on the basis of their attributes), ordering (sequencing entities according to a given criterion), and representing (changing the form, but not the substance of information).[49]
Problem Solving	Analyzing a perplexing or difficult situation for the purpose of generating a solution.[50]
Procedural Knowledge	Knowledge of how to perform various tasks.[51]
Recalling Skills	Remembering skills that involve retrieving information from long-term memory.[52]
Remembering Skills	Core thinking skills that involve conscious efforts to store and retrieve information. Encoding (storing information in long-term memory) and recalling (retrieving information from long-term memory).[53]
Rote Memorization	Remembering information by repetition without necessarily understanding the meaning of the information. Considered to be a very low level of learning but occasionally necessary. Memorization can be hampered by the serial position effect (the tendency to remember the beginning and the end but not the middle of the list).[54]
Teleconferencing	Two-way electronic communication between two or more groups, or three or more individuals, who are in separate locations. Includes group communication via audio, audiographs, video, and computer systems.[55]
Thinking	The process of creating a structured series of connective transactions between items of perceived information.[56]

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[49] Ibid.

[50] Ibid.

[51] *Bloom's taxonomy*. http://www.tecweb.org/eddevel/blooms.html

[52] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

[53] Ibid.

[54] *Dictionary.com*. http://www.dictionary.com/cgi-bin/dict.pl?term=memorization

[55] *Bloom's taxonomy*. http://www.tecweb.org/eddevel/blooms.html

[56] Copyright 2000 © CITL, Cognition & Instructional Technologies Laboratories, *Intelligent tutors: Computational intelligence*. http://citl-s2.tamu.edu/citlsite/intelligent-tutors.htm

ACRONYM LIST

ADL	Advanced Distributed Learning
AEC	Automated Electronic Classroom
AFDLO	Air Force Distance Learning Office
AFIT	Air Force Institute of Technology
ARI	Army Research Institute
ASTD	American Society of Training and Development
ATN	Air Technology Network
C3I	Command, Control, Communication, and Intelligence
CMC	Computer-mediated Communication
CTA	Cognitive Task Analysis
DL	Distributed Learning
DO	Delivery Order
DSTR	Digital Skills Training Research
ES	Effect Size
FA	Field Artillery
GETN	Government Education and Training Network
ISD	Instructional Systems Development
KOs	Knowledge Objects
KSA	Knowledge, Skills, and Attitudes
MI	Military Intelligence
NPS	Naval Postgraduate School
RCOs	Reusable Content Objects
RLOs	Reusable Learning Objects
SCORM	Sharable Courseware Object Reference Model
SD	Standard Deviation
TRADAM	Training Dekuvery Assessment Model
VTT	Video Teletraining

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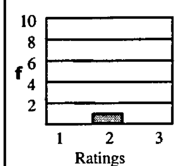
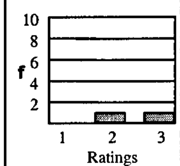
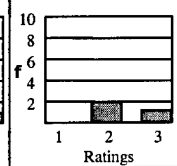
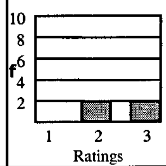
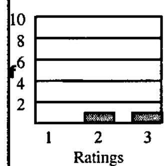
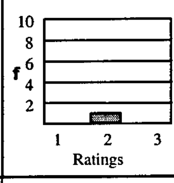
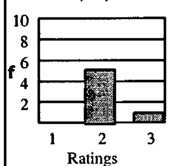
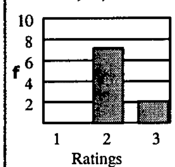
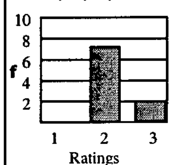
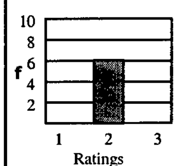
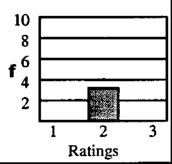
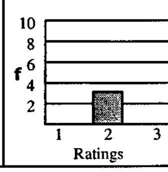
APPENDIX C – DETAILED RATINGS MATRIX

DETAILED RATINGS MATRIX

	Declarative	Perceptual-Motor	Procedural	Cognitive	Leadership
Audio	Overall Rating 2 ES ?	Overall Rating 3 ES Medium	Overall Rating 2 ES ?	Overall Rating 2 ES ?	Overall Rating 2 ES Medium
Studies	*14* 	*14, 15* 	*5, 14, 15* 	*4, 6, 14, 15* 	*4* 
Video	Overall Rating 2 ES Low	Overall Rating 2 ES ?	Overall Rating 2 ES ?	Overall Rating 2 ES ?	Overall Rating 2 ES ?
Studies	*9* 	*2, 3, 8, 10, 11, 12, 13* 	*1, 2, 3, 5, 7, 10, 11, 12, 13* 	*1, 2, 4, 5, 7, 9, 10, 11, 13* 	*1, 2, 4, 9, 12, 13* 
CMC/CBT	Overall Rating ES	Overall Rating ES	Overall Rating 2 ES ?	Overall Rating 2 ES ?	Overall Rating 2 ES ?
Studies			*6, 12, 13* 	*6, 12, 13* 	*14*